UNITED STATES PATENT APPLICATION

For

MICROELECTRONIC ASSEMBLY HAVING A REDISTRIBUTION CONDUCTOR OVER A MICROELECTRONIC DIE

Inventors:

Brian C. Taggart
Robert M. Nickerson
Ronald L. Spreitzer

Prepared by:

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN, LLP
12400 WILSHIRE BOULEVARD
SEVENTH FLOOR
LOS ANGELES, CALIFORNIA 90025-1026
(408) 720-8300

Attorney Docket No.: 042390P18809

"Express Mail" mailing label number: EV 409363811 US
Date of Deposit: 4-20-04
I hereby certify that I am causing this paper or fee to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia, 22313-1450.

Tina Wainright
(Typed or printed name of person mailing paper or fee)

Tina A. Wainright
(Signature of person mailing paper or fee)

4-20-04
(Date signed)

MICROELECTRONIC ASSEMBLY HAVING A REDISTRIBUTION CONDUCTOR OVER A MICROELECTRONIC DIE

BACKGROUND OF THE INVENTION

1). Field of the Invention

[0001] This invention relates to a microelectronic assembly and the manner according to which contacts and terminals can be connected for purposes of redistributing current.

2). Discussion of Related Art

[0002] Integrated circuits are often manufactured in and on semiconductor wafers. A wafer is subsequently "singulated" or "diced" into individual dies. Each die is then mounted to a package substrate for purposes of structural integrity and providing signals, power, and ground to and from an integrated circuit in the die. Wirebonding wires may connect contacts on the die to terminals on the substrate. The terminals on the substrate are, in turn, connected through vias and other conductors to solder balls on an opposing side of the substrate.

[0003] It is often also required to connect one of the terminals to a solder ball on an opposing side of the die. In order to accomplish such redistribution of signals, conductors are formed out of metal layers in the substrate. More metal layers allow for more flexibility in design and more connections that can be made between components located on opposing sides of the die. A large number of metal layers in

the substrate, however, increases the overall cost of the substrate. There is thus a trade-off between flexibility in the redistribution and the cost of the microelectronic assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The invention is described by way of examples with reference to the accompanying drawings, wherein:

[0005] Figure 1 is a plan view of a microelectronic assembly according to one embodiment of the invention;

[0006] Figure 2 is a cross-sectional side view on 2-2 in Figure 1;

[0007] Figure 3 is a cross-sectional side view on 3-3 in Figure 1;

[0008] Figure 4 is a plan view of a microelectronic assembly according to another embodiment of the invention;

[0009] Figure 5 is a cross-sectional side view on 5-5 in Figure 4;

[0010] Figure 6 is a plan view of a microelectronic assembly, according to a further embodiment of the invention; and

[0011] Figure 7 is a cross-sectional view on 7-7 in Figure 6.

DETAILED DESCRIPTION OF THE INVENTION

[0012] A microelectronic assembly is provided, having redistribution conductors that are formed over a microelectronic die of the assembly instead of through a substrate to which the microelectronic die is mounted. A redistribution conductor is formed by a pair of contacts on the die and a conductive portion connecting the contacts to one another. A wirebonding wire is attached to each contact. One of the wirebonding wires may be used to connect to a terminal on the substrate, a terminal on another die, or to another contact on the same die.

[0013] Figures 1, 2, and 3 illustrate a microelectronic assembly 10, according to one embodiment of the invention, including a package substrate subassembly 12, a die subassembly 14, and wirebonding wires 16.

[0014] Referring specifically to Figure 2, the package substrate subassembly 12 includes a package substrate 18, conductors 20 formed in the substrate 18, terminals 22 at an upper surface of the substrate 18, and solder ball contacts 24 on a lower surface of the substrate 18. The substrate 18 is multi-layer substrate with a plurality of alternating dielectric and metal layers. The conductors 20 are formed out of the metal layers and vias that are formed through the dielectric layers. In the example illustrated, two of the terminals 22A are connected to one another by one of the conductors 20.

[0015] Each one of the solder ball contacts 24 is also connected through a respective conductor 20 to one or more of the terminals 22A. The number of connections that can be made between the solder ball contacts 24 and the terminals

22A depends on the number of metal layers in the substrate 18; a larger number of metal layers allows for a larger number of connections. The number of metal layers in the substrate 18 should, however, be maintained as low as possible to reduce the cost of the substrate 18.

[0016] The die subassembly 14 includes a microelectronic die 25 and contacts 26 formed at an upper surface of the die 25. The die 25 includes a die substrate 28 and an integrated circuit 30 formed on the die substrate 28. The contacts 26 include functional contacts 26A that are connected to the integrated circuit 30. The integrated circuit 30 includes a multitude of transistors and other electronic components that are interconnected with one another. Signals, power, and ground can be provided through the functional contacts 26A to or from the electronic components of the integrated circuit 30.

[0017] The wirebonding wires 16 include functional wirebonding wires 16A. Each functional wirebonding wire 16A has one end portion attached to one of the functional terminals 22A, and an opposing end portion attached to one of the functional contacts 26A. The functional contacts 26A are connected through the respective functional wirebonding wires 16A and the respective functional contacts 26A to the integrated circuit 30.

[0018] Referring to Figure 3, a re-routing conductor is formed by a pair of re-routing terminals 22Bi and 22Bii, a pair of re-routing wirebonding wires 16Bi and 16Bii, a pair of re-routing contact pads 26Bi and 26Bii, and an intermediate wirebonding wire 34. The re-routing terminals 22Bi and 22Bii are located on

opposing sides and outside an area of the die subassembly 14. Each one of the re-routing contacts 26Bi and 26Bii is located near an edge of the die 25 and close to a respective one of the re-routing terminals 22Bi or 22bii, respectively. Both re-routing contacts 26Bi and 26Bii are disconnected from the integrated circuit 30. The re-routing contacts 26Bi and 26Bii are thus not in direct communication with the integrated circuit 30. Any communication from one of the re-routing contacts 26Bi or 26Bii is via one of the re-routing wirebonding wires 16Bi and re-routing terminals 22Bi. The intermediate wirebonding wire 34 has opposing ends connected to the respective re-routing contacts 26Bi and 26Bii. A central portion of the intermediate wirebonding wire 34 extends across the integrated circuit 30.

[0019] As illustrated in Figures 2 and 3, an encapsulant 40 is formed. The encapsulant 40 covers the die subassembly 14, exposed upper surfaces of the package substrate subassembly 12, and also the intermediate wirebonding wire 34.

[0020] Referring again to Figure 1, the functional terminals 22A, functional contacts 26A, and functional wirebonding wires 16A are located along the left and right edges of the die subassembly 14. The re-routing terminals 26Bi and 26Bii are located along back and front edges of the die subassembly 14. A re-routing conductor trace 42 connects one of the functional terminals 22A along the left edge of the die subassembly 14, with one of the re-routing terminals 22Bi along the back edge of the die subassembly 14. A further conductor 44 connects one of the re-routing terminals 22Bii with one of the solder ball contacts 24. It can thus be seen that the functional terminal 22A in the top left is connected to the solder ball contact

24 in the bottom right, with a minimal amount of re-routing within the package substrate subassembly 12 and by using the re-routing conductor formed by the redistribution conductor formed by the re-routing terminal 22Bi, wirebonding wire 16Bi, re-routing contact 26Bi, intermediate wirebonding wire 34, re-routing contact 26Bii, wirebonding wire 16Bii, and re-routing terminal 22Bii.

[0021] Although only a single pair of re-routing terminals 22Bi and 22Bii is shown, it should be understood that there may be additional re-routing conductors that are similar to the re-routing conductor illustrated in Figure 1. For this purpose, a plurality of intermediate wirebonding wires 34 are shown parallel to one another in Figure 1. Each intermediate wirebonding wire 34 forms part of a separate re-routing conductor from the back edge to the front edge of the die subassembly 14.

[0022] Figures 5 and 6 illustrate a microelectronic assembly 110 according to another embodiment of the invention, including a package substrate subassembly 112, a first die subassembly 114, and a second die subassembly 150. The microelectronic assembly 110 further has a re-routing conductor formed by a first redistribution terminal 122Bi, a first redistribution wirebonding wire 116Bi, a pair of redistribution contacts 126Bi and 126 Bii, a redistribution conductor trace 134, a second redistribution wirebonding wire 116Bii, and a second redistribution terminal 122Bii.

[0023] The package substrate subassembly 112 and the first die subassembly 114 are similar to the package substrate subassembly 12 and die subassembly 14 of Figure 1. In this respect, the similarities between Figures 3 and 5 should be evident.

[0024] The first redistribution wirebonding wire 116Bi has opposing ends that are attached respectively to the first redistribution terminal 122Bi and to the first redistribution contact 126Bi. The redistribution conductor trace 134 has opposing ends connected to the redistribution contacts 126Bi and 126Bii. The redistribution conductor trace 134 runs over the integrated circuit of the first die subassembly 114, without communicating therewith. The second die subassembly 150 is placed over the redistribution conductor trace 134, with the redistribution contacts 126Bi and 126Bii on opposing sides and outside an area of the second die subassembly 150.

[0025] The second die subassembly 150 is located on the first die subassembly 114. The second die subassembly 150 includes a microelectronic die 152 and a plurality of terminals 154 formed on the die 152. The die 152 includes a die substrate 156 and an integrated circuit 158 formed on the die substrate 156. The terminals 154 and the first redistribution terminal 122Bi are formed along edges of the second die subassembly 150, and are in direct communication with the integrated circuit 158.

[0026] The second redistribution wirebonding wire 116Bii has opposing ends connected respectively to the second redistribution contact 126Bii, and the second redistribution terminal 122Bii.

[0027] It can thus be seen that the first redistribution terminal 122Bi on the left of the second die subassembly 150 is connected to the second redistribution terminal 122Bii without the need for re-routing any signals through a substrate of the package substrate subassembly 112. Further functional wirebonding wires 160 can be used to connect terminals 162 of the package substrate subassembly 112 directly

to terminals 154 of the second die subassembly 150.

[0028] Figures 6 and 7 illustrate a microelectronic assembly 210 according to a further embodiment of the invention. The microelectronic assembly 210 includes a package substrate subassembly 212, a die subassembly 214, two redistribution conductors formed by elongate redistribution pads 270, and redistribution wirebonding wires 272.

[0029] The package substrate subassembly 212 includes a substrate 218, solder ball contacts 224 on a lower side of the substrate 218, and terminals 222 on an upper surface of the substrate 218.

[0030] The die subassembly 214 includes a die 225 and plurality of contacts 226 on the die 224. The die 225 includes a die substrate and an integrated circuit formed on the die substrate.

[0031] The terminal 222A is connected through the redistribution wirebonding wire 272A to the contact 226A. The contact 226A is connected through the redistribution wirebonding wire 272B to the redistribution pad 270A. The redistribution pad 270A is connected through the wirebonding wire 272C to the contact 226B. The contact 226B is connected to the integrated circuit of the die subassembly 214. Similarly, a redistribution conductor is formed by the redistribution terminal 222B, redistribution wirebonding wire 272D, redistribution contact 226C, redistribution wirebonding wire 272E, redistribution pad 270B, redistribution wirebonding wire 272F, and contact 226D.

[0032] It can thus be seen that two redistribution conductors are formed, each with

a respective redistribution pad 272. The redistribution pads 272 allow for more flexibility in design of redistribution conductors.

[0033] While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative and not restrictive of the current invention, and that this invention is not restricted to the specific constructions and arrangements shown and described since modifications may occur to those ordinarily skilled in the art.